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IMAGE ANALYSIS STUDY OF A BASE METAL ORE FOR ESSO RESOURCES CANADA LIMITED

by

W. Petruk
Mineral Processing Laboratory

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ABSTRACT

Two samples composed of coarse grained particles of a base metal ore and one of a flotation feed which had been ground to 80% minus 325 mesh were analysed by image analysis for Esso Resources Canada Limited. The data for the ore samples provided a basis for predicting the minimum and optimum grinds that would be required to liberate the sphalerite, chalcopyrite and bornite. The flotation feed sample had been ground to the optimum grind for liberating sphalerite. The proportions of sphalerite and copper minerals that occur as free grains in it were determined, and the particles containing unliberated mineral grains were classified. The mineral liberation data and the particle classifications were used to predict optimum recoveries from the flotation feed.

ANALYSE D'IMAGES D'UN MINERAI À MÉTAL DE BASE POUR ESSO RESOURCES CANADA LIMITED

William Petruk

RÉSUMÉ

Deux échantillons, l'un composé de particules à grains grossiers d'un minerai d'un métal de base, l'autre d'alimentation de flottation broyée de manière à ce que 80 % des particules passent au tamis 325 mailles au pouce ont été soumis à une analyse d'images pour Esso Resources Canada Limited. Les échantillons de minerai ont permis d'obtenir des données de base pour la prédiction des granulométries minimales et optimales nécessaires pour libérer la sphalérite, la chalcopyrite et la bornite. L'échantillon d'alimentation de flottation avait été broyé au niveau optimal permettant de libérer la sphalérite. Les proportions de sphalérite et des minéraux de cuivre sous forme de grains libres ont été déterminées et les particules contenant des grains minéraux non libres ont été classées. Ces données ont servi à prédire les récupérations optimales à partir de l'alimentation de flottation.

INTRODUCTION

An image analysis study of a base metal ore was performed for Esso Resources Canada Limited. It was arranged that B. Snider and S. Lee of Esso Resources be in attendance in the image analysis laboratory during the analysis to observe the approach used in performing the analysis. The purpose of the analysis was to determine the liberation size of the minerals and to determine the characteristics of the ground ore.

METHOD OF INVESTIGATION

Mr. Snider brought two ore samples, labelled samples 14B and 4C, and Mr. Rawling of Esso Minerals submitted a sample that had been ground as flotation feed. The ore samples consisted of coarse grained pieces mounted in polished sections. The polished sections, however, had too much relief for analysis, consequently they were repolished. A polished section was prepared from the ground flotation feed samples.

The ore samples were analysed with the Kontron image analyser on line with an optical microscope to determine the quantities of sphalerite, bornite, chalcopyrite and pyrite; and to determine size distributions for the first three minerals.

The flotation feed samples was analysed with the image analysis system using the SEM as the image input. The quantities of minerals, liberation, and size distributions of the free minerals were determined. The sphalerite and galena were not differentiated and were called sphalerite. Similarily the chalcopyrite, bornite and tetrahedrite were not differentiated and were called copper minerals.

RESULTS

The relative quantities of the metallic minerals present in each ore sample, and liberations for the sphalerite and copper minerals in the flotation feed sample are given in Table 1.

Size distributions, using the equivalent circular diameter as the size of each particle are given in Fig. 1, 2 and 3 for sphalerite, bornite and chalcopyrite respectively in sample 14B; in Fig. 5, 6 and 7 for the same minerals in sample 4C; and in Fig. 9, 10, 11, 12, 13 and 14 for the metallic minerals, free sphalerite, free copper minerals, combined pyrite-sphalerite particles, combined pyrite-copper minerals particles and combined sphalerite-copper minerals particles in the flotation feed sample. In these figures the data are reported as numbers of particles in each size range. No interpretations can be made from data reported in this manner.

Table 1. Mineral quantities and liberation

MINERAL	ORE SAMPLE		FLOTATION FEED					
	14B Wt %	4C Wt %	Wt %	FREE, %			UNLIBERATED, %	
				+2.2 µm	-2.2 µm	TOTAL	In Cu-SP	In PY
Pyrite	89.2	86.5	81.2					
Sphaler.	6.0	6.2	12.5	66	6	72	19	9
Chalcopyr.	3.8	5.0						
Bornite	1.0	2.3						
All Cu-minerals			6.3	50	11	61	18	21
TOTAL	100.0	100.0	100.0					

The data were therefore, converted to % of surface areas in polished section covered by each mineral in each size range and replotted (Fig. 4 and 8). The replotted data are equivalent to wt% passing and they give the size distributions for the sphalerite, bornite and chalcopyrite in the ore of samples 14B and 4C.

The replotted data are used to determine the minimum and optimum grinds by following the empirically established guideline: (1) the minimum grind is the size distribution of the mineral as shown in cumulative size distribution, and the optimum grind is the point where the size distribution curve flattens. The interpreted minimum and optimum grinds are given in Table 3 as 80% minus ??? μm.

Table 2. Types of middling particles

Ave. %	copper minerals in copper minerals-pyrite particles	=71
Ave. %	copper minerals in copper minerals-sphalerite particles	=34
Ave. %	sphalerite in copper minerals-sphalertie particles	=66
Ave. %	sphalerite in sphalertie-pyrite particles	=31

MILL FEED

Size distribution data (Fig. 9) show that the ore has been ground to about 80% minus 325 mesh (44 μm) hence it has been ground to approximately the optimum grind for sphalerite and chalcopyrite. At this grind 72% of he sphalerite and 61% of the copper minerals are completely liberated with only 6% of the sphalerite being minus 2 μm particles (Table 1). An additional 19% of

Table 3. Minimum and optimum grinds

MINERAL	SAMPLE 14B		SAMPLE 4C	
	Minimum μm	Optimum μm	Minimum μm	Optimum μm
Sphalerite	170	30	300	40
Bornite	85	15	90	13
Chalcopyrite	130	25	160	20

the sphalerite is left as inclusions in sphalerite-pyrite particles; some of the particles contain less than 30% sphalerite, others contain 40-60% sphalerite but are very small, it would not be economical to liberate the sphalerite from these two types of particles. By contrast some sphalerite is in particles that contain more than 65% sphalerite (Fig. 15); these particles would tend to be pulled into the Zn concentrate, whereas those with less than 65% sphalerite would be rejected to the tailings.

The sphalerite-copper mineral grains are composed of all classes of particles which contain from 5% to 95% sphalerite with average particles containing 66% sphalerite (Table 2).

The following zinc recovery is predicted from the data in tables 1 and 2, assuming efficient plant operation:

1. 96% of the free sphalerite = 72 x .96 = 69
2. 66% of sphalerite in sphalerite-copper minerals = 19 x .66 = 12.5
3. 31% of the sphalerite in sphalerite-pyrite = 9 x .31 = 2.8

Total expected zinc recovery 84%. This Zn concentrate, however, will contain some copper.

For the copper minerals there is a lower liberation and a higher percentage of slimes. The characteristics of the copper minerals-pyrite middlings, however, show an ideal distribution (Fig. 16). There is a large proportion of copper minerals-pyrite particles that contain more than 65% copper minerals and a large proportion that contains less than 30% copper minerals. The former will tend to be pulled into a copper concentrate and the latter will be rejected into the tailings. This suggests that regrinding would not significantly improve copper recoveries.

The following recovery of Cu minerals is predicted:

95% of free minerals larger than 2.2 μm = 50 x .95 = 47
75% of free minerals smaller than 2.2 μm = 11 x .75 = 8
34% of Cu in copper minerals-sphalerite particles = 18 x .34 = 12
40% of Cu in copper minerals-pyrite = 21 x .40 = 8
Total predicted copper recovery 75%

These are the predicted optimum recoveries from this ore.

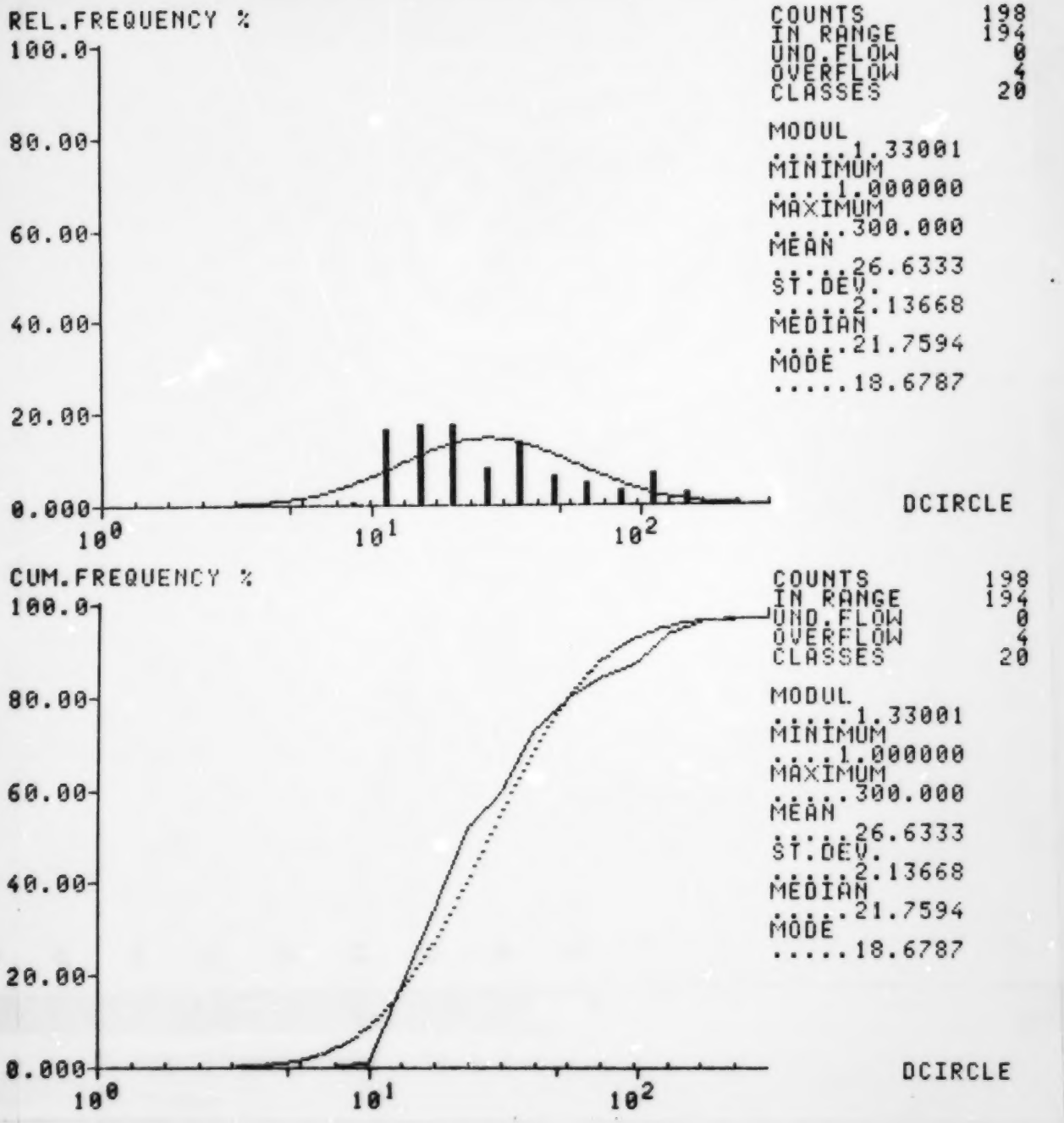

Fig. 1 - Size distribution of sphalerite in Sample 14B, plotted as number of grains vs size in micrometers.

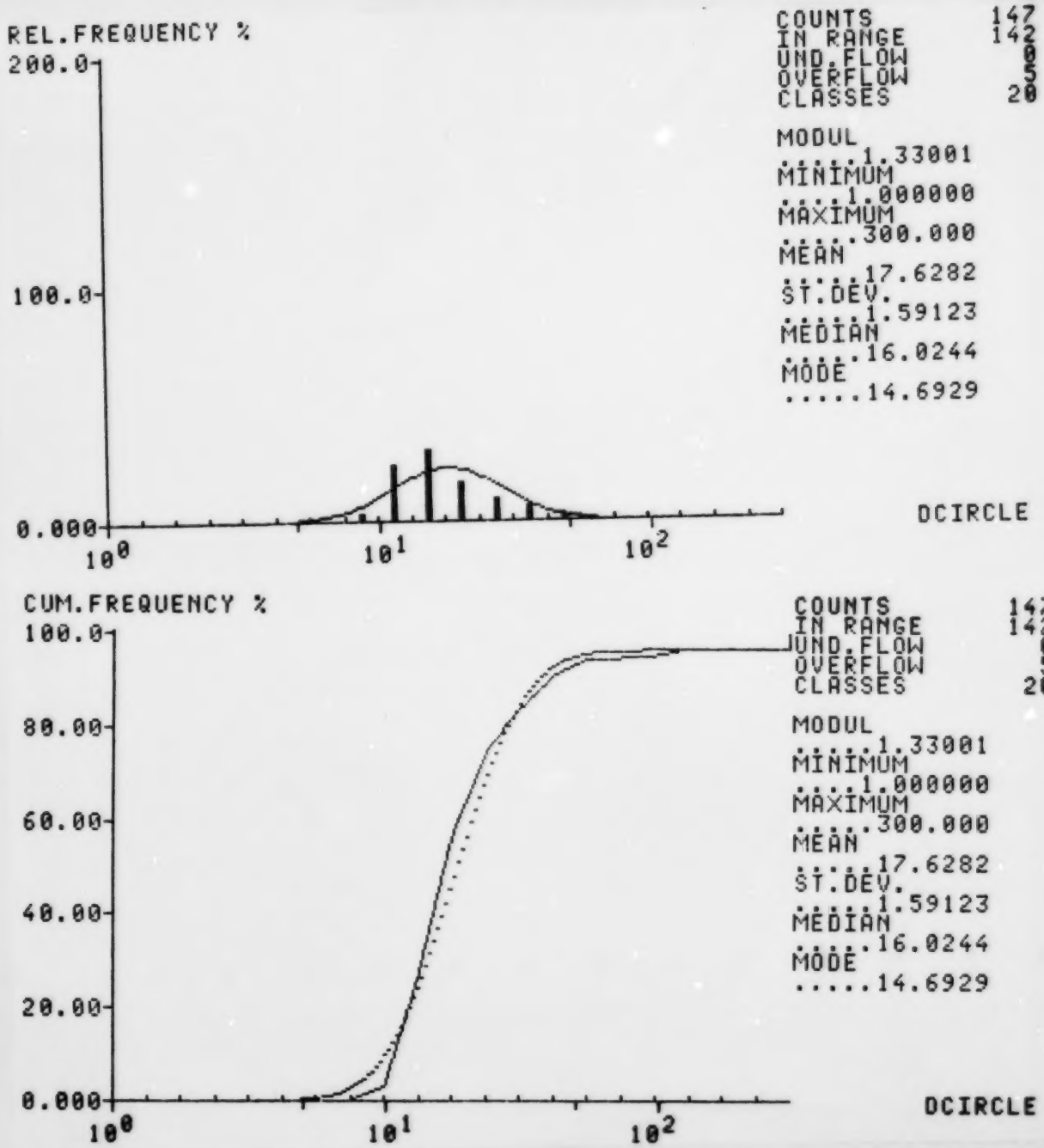

Fig. 2 - Size distribution of bornite in Sample 14B, plotted as numbers of grains vs size, in micrometers.

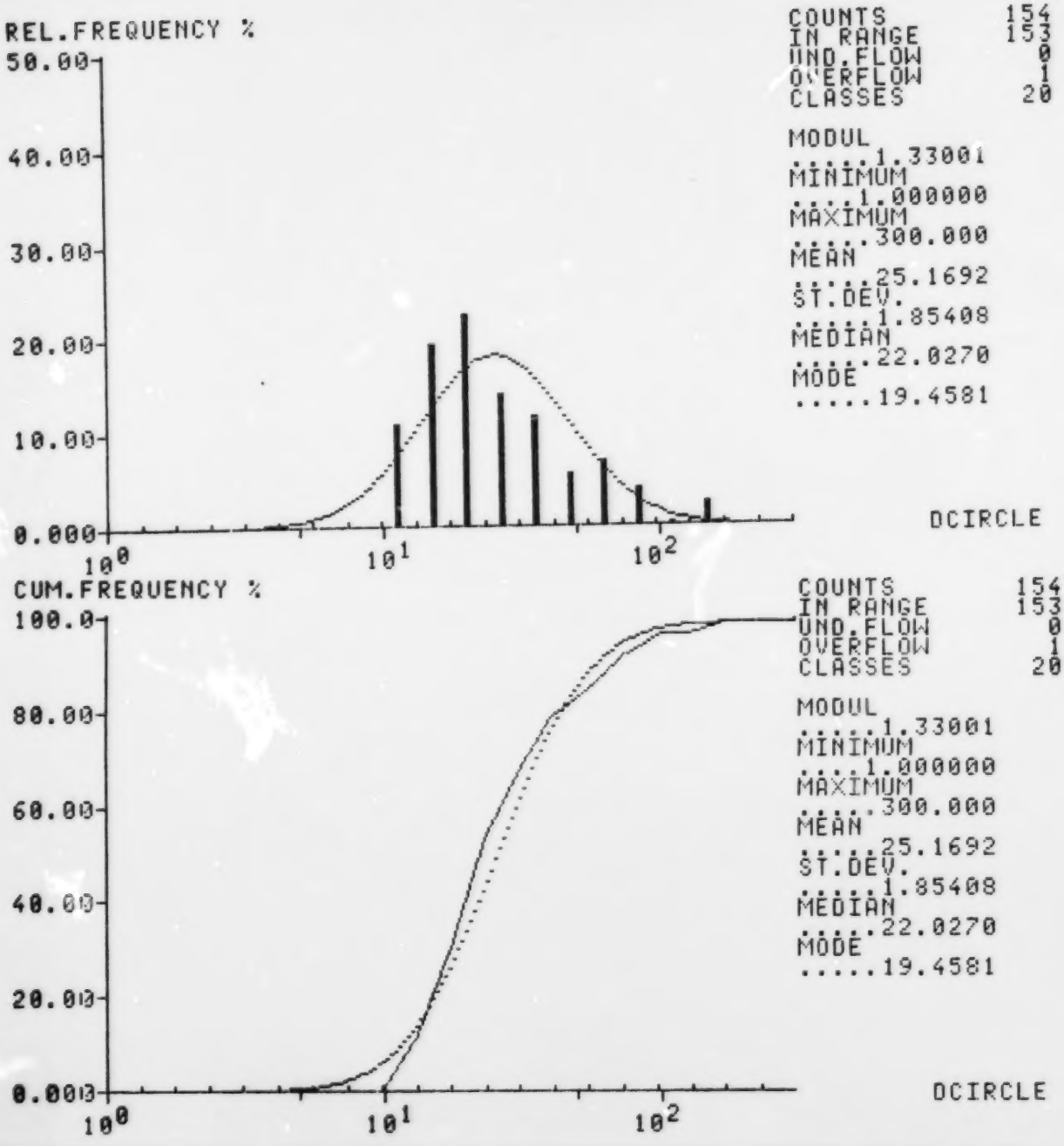

Fig. 3 - Size distribution of chalcopyrite in Sample 14B, plotted as number of grains vs size in micrometers.

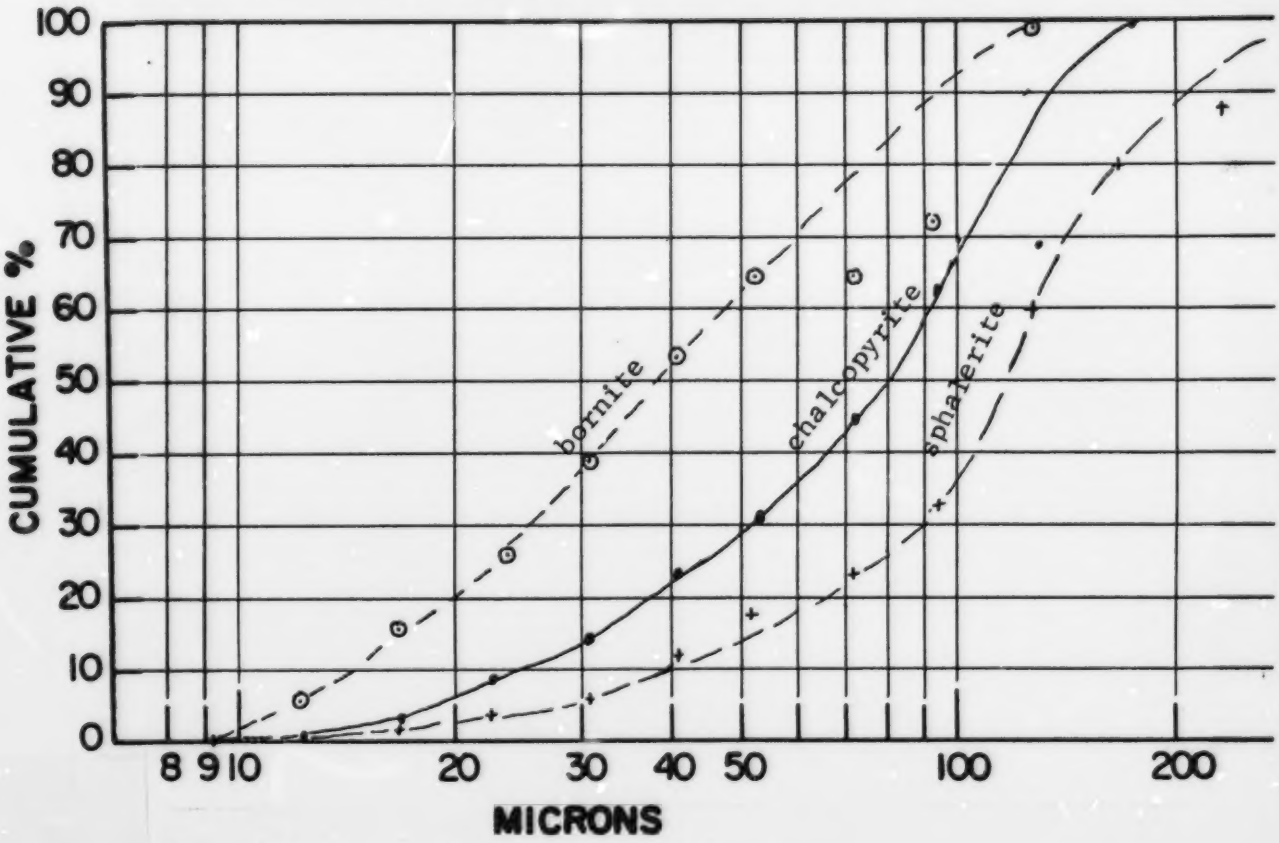

Fig. 4 - Cumulative size distribution for the minerals in sample 14B, plotted as areas % covered by each mineral in polished section vs size.

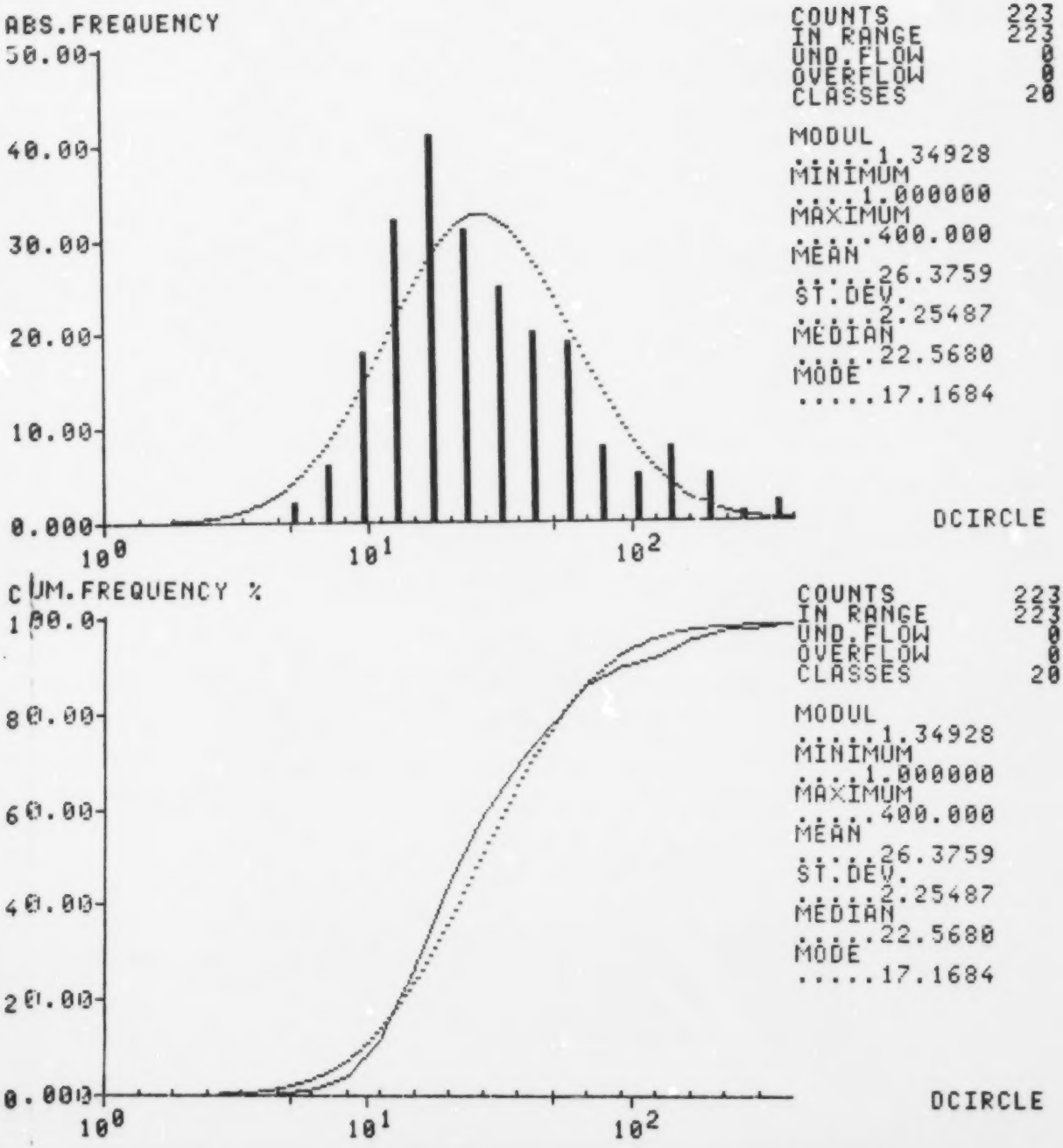

Fig. 5 - Size distribution of sphalerite in Sample 4C, plotted as number of grains vs size in micrometers.

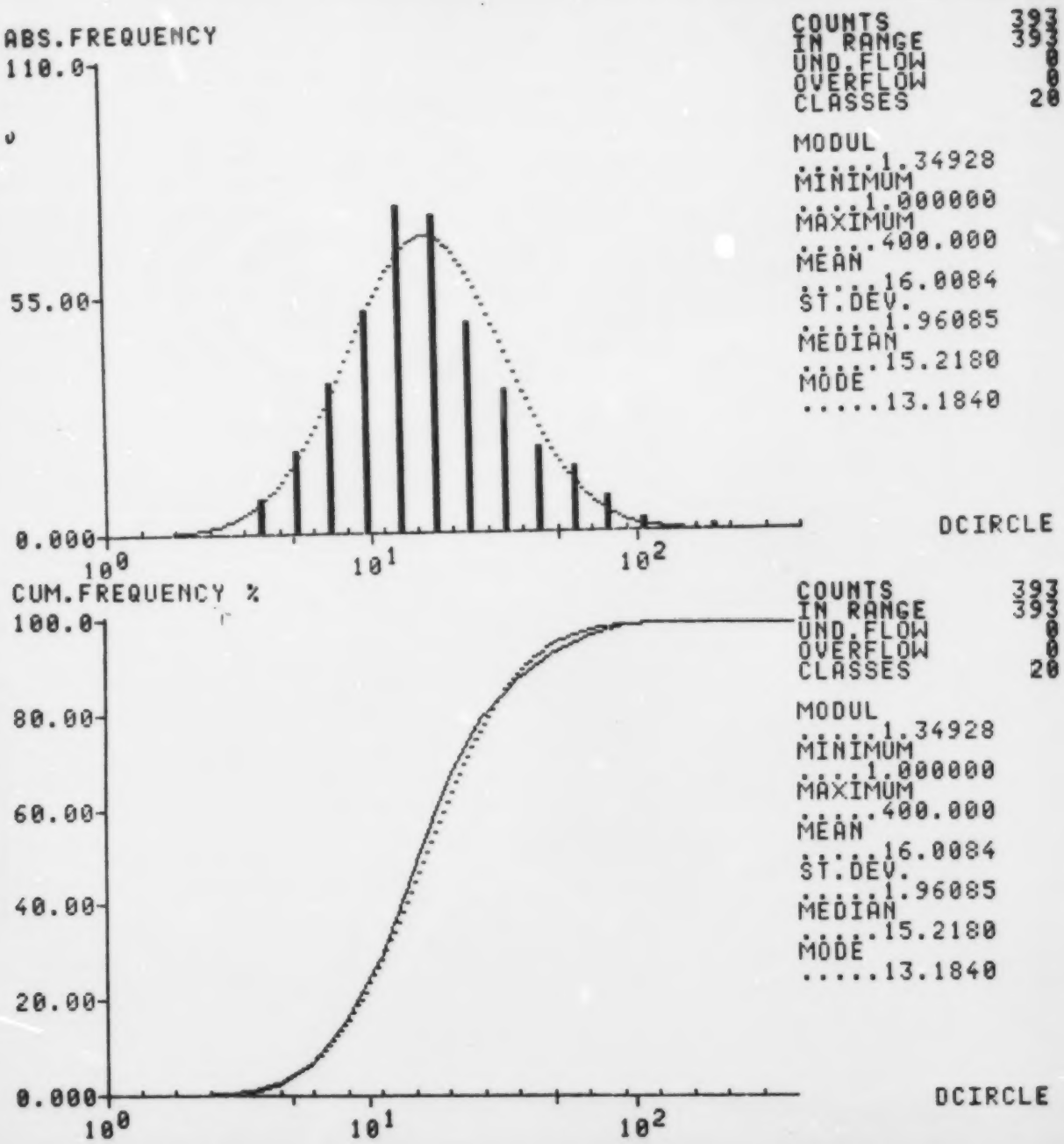

Fig. 6 - Size distribution of bornite in sample 4C, plotted as number of grains vs size in micrometers.

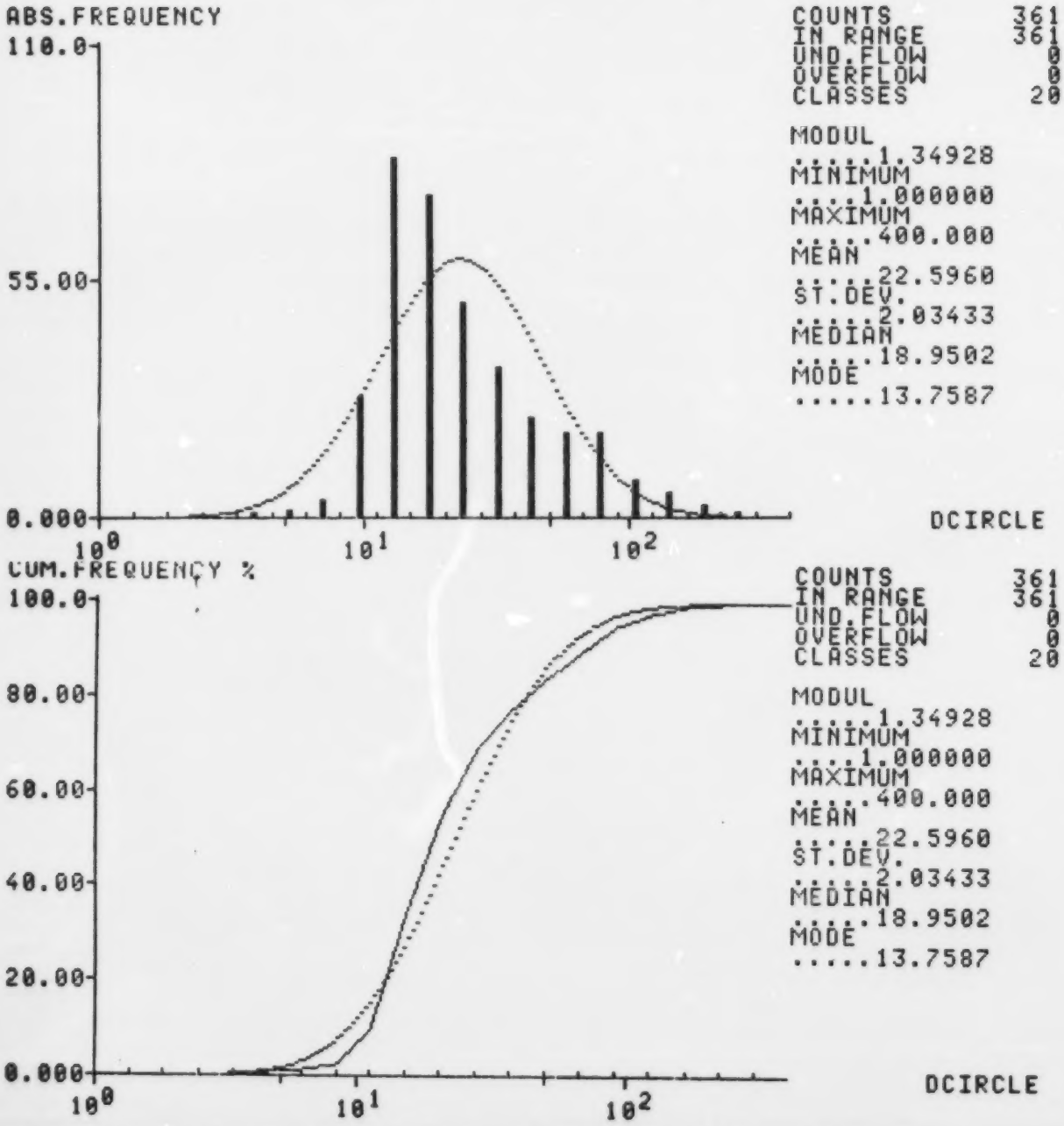

Fig. 7 - Size distributions of chalcopyrite in sample 4C, plottedf as number of grains vs size in micrometers.

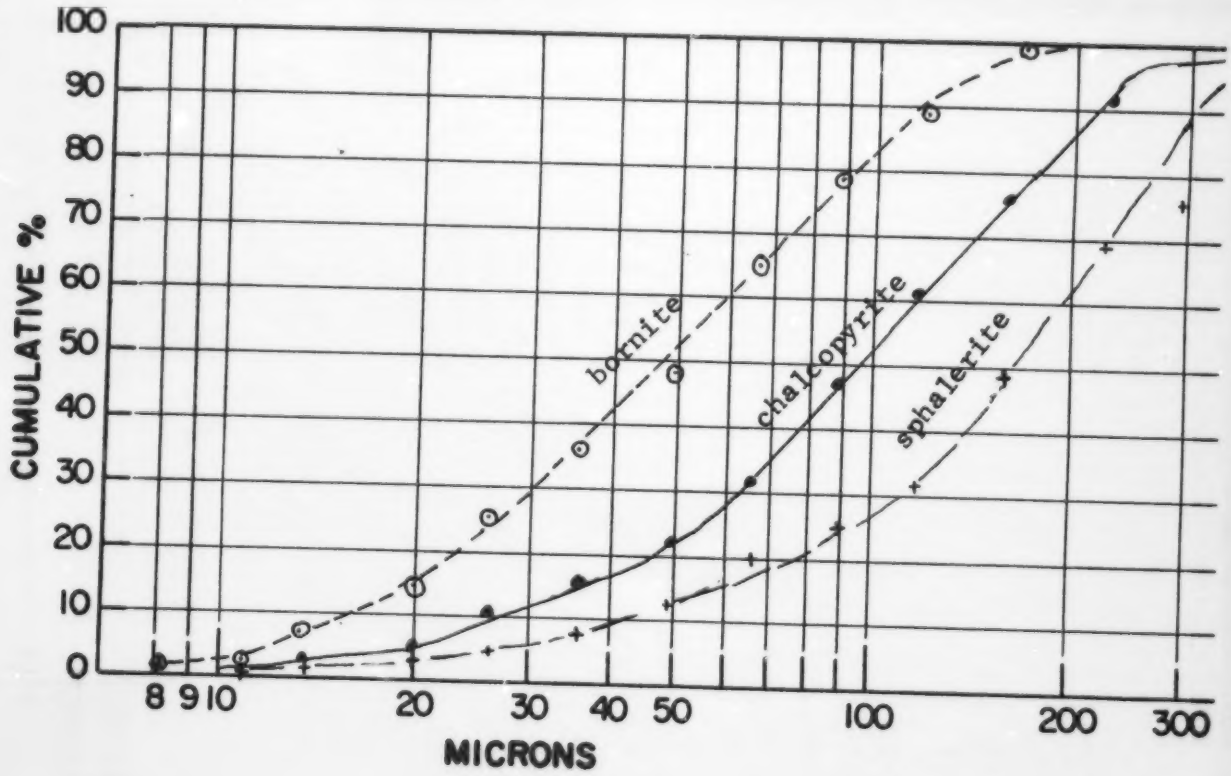

Fig. 8 - Cumulative size distrubitions for the minerals in sample 4C, plotted as area % covered by each mineral in polished sections vs size.

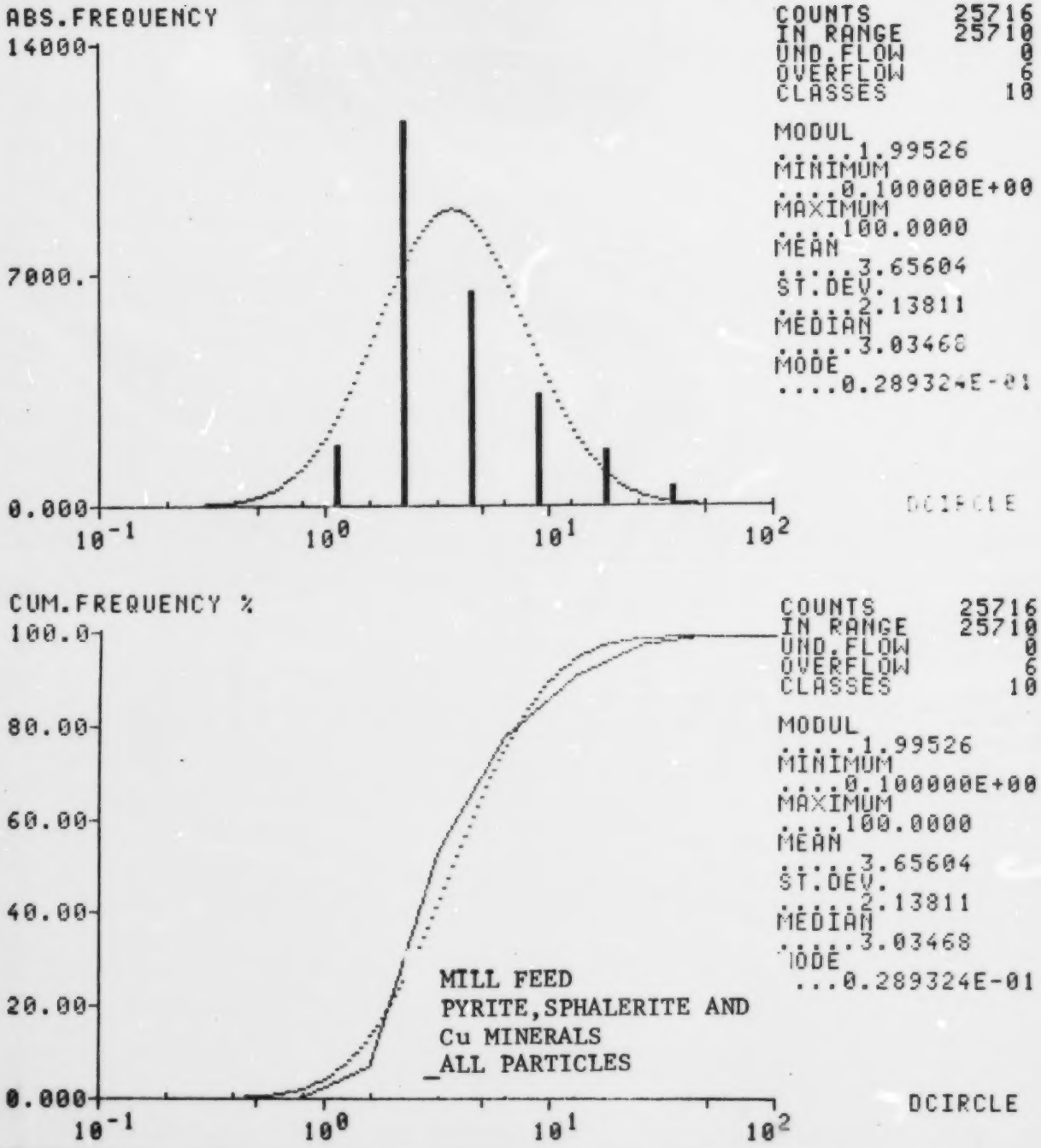

Fig. 9 - Size distribution of all particles in flotation feed, plotted as number of grains vs size in micrometers.

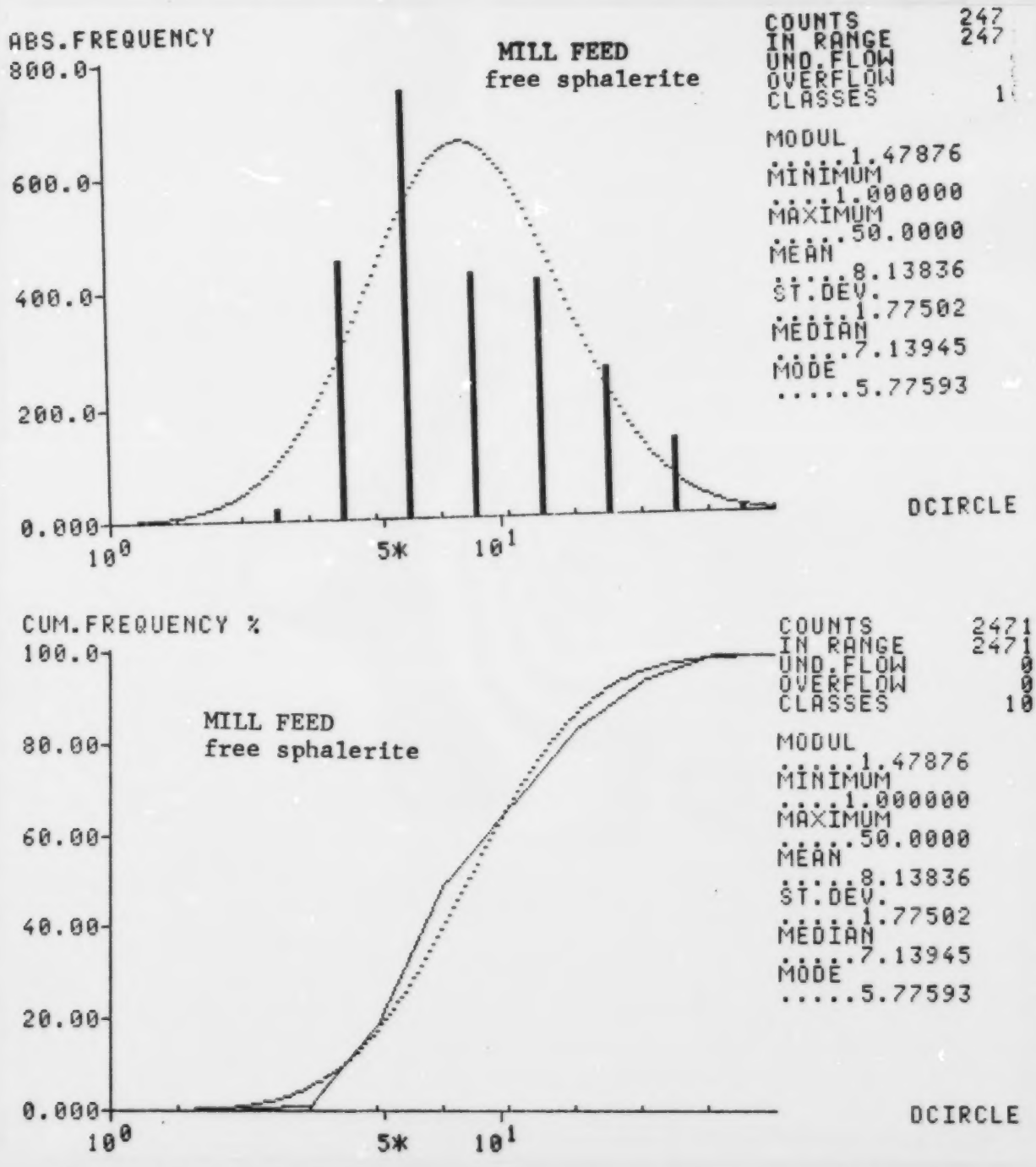

Fig. 10 - Size distribution of free sphalerite in flotation feed, plotted as number of grains vs size in micrometers.

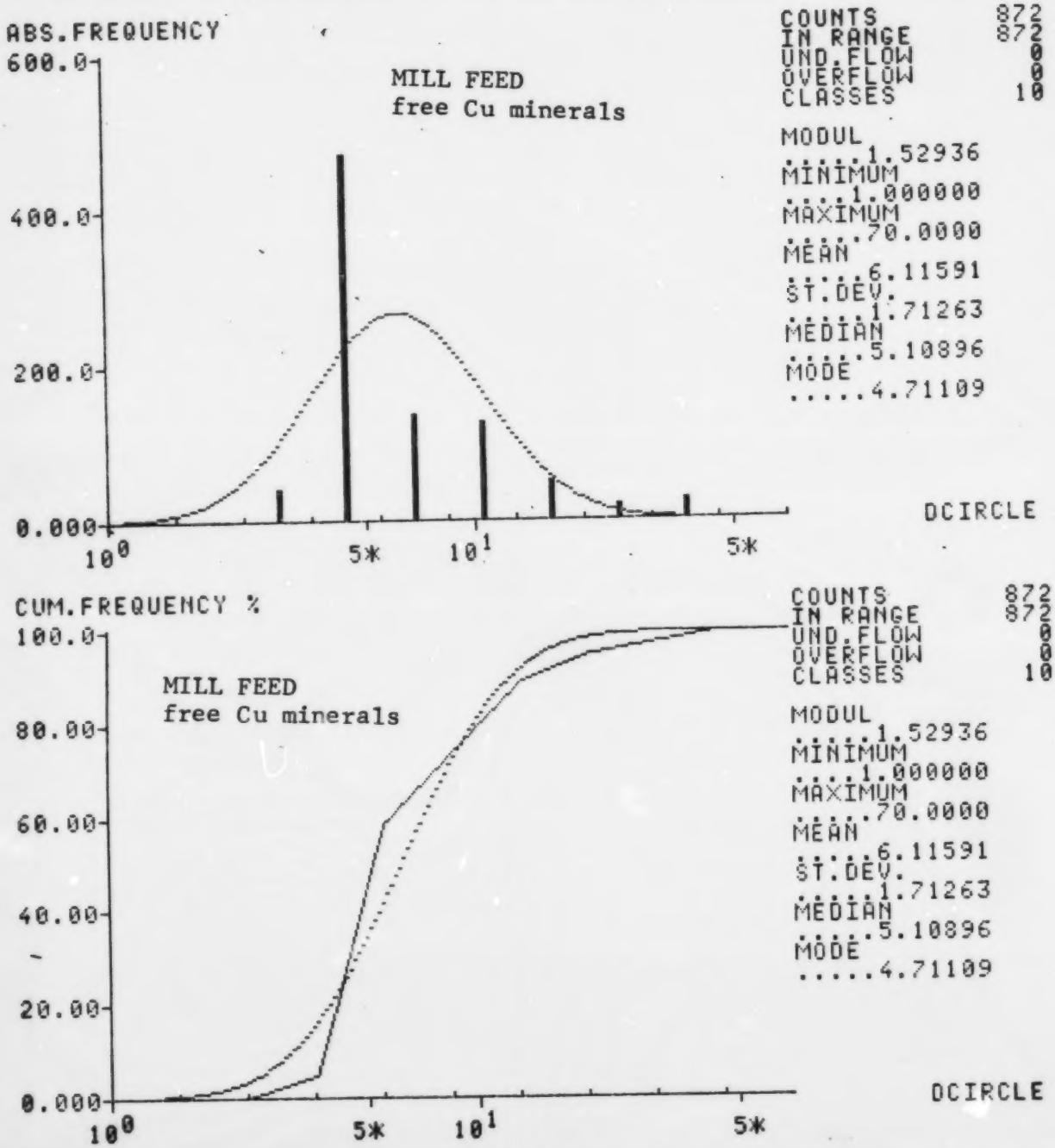

Fig. 11 - Size distribution of free copper minerals in flotation feed, plotted as number of grains vs size in micrometers.

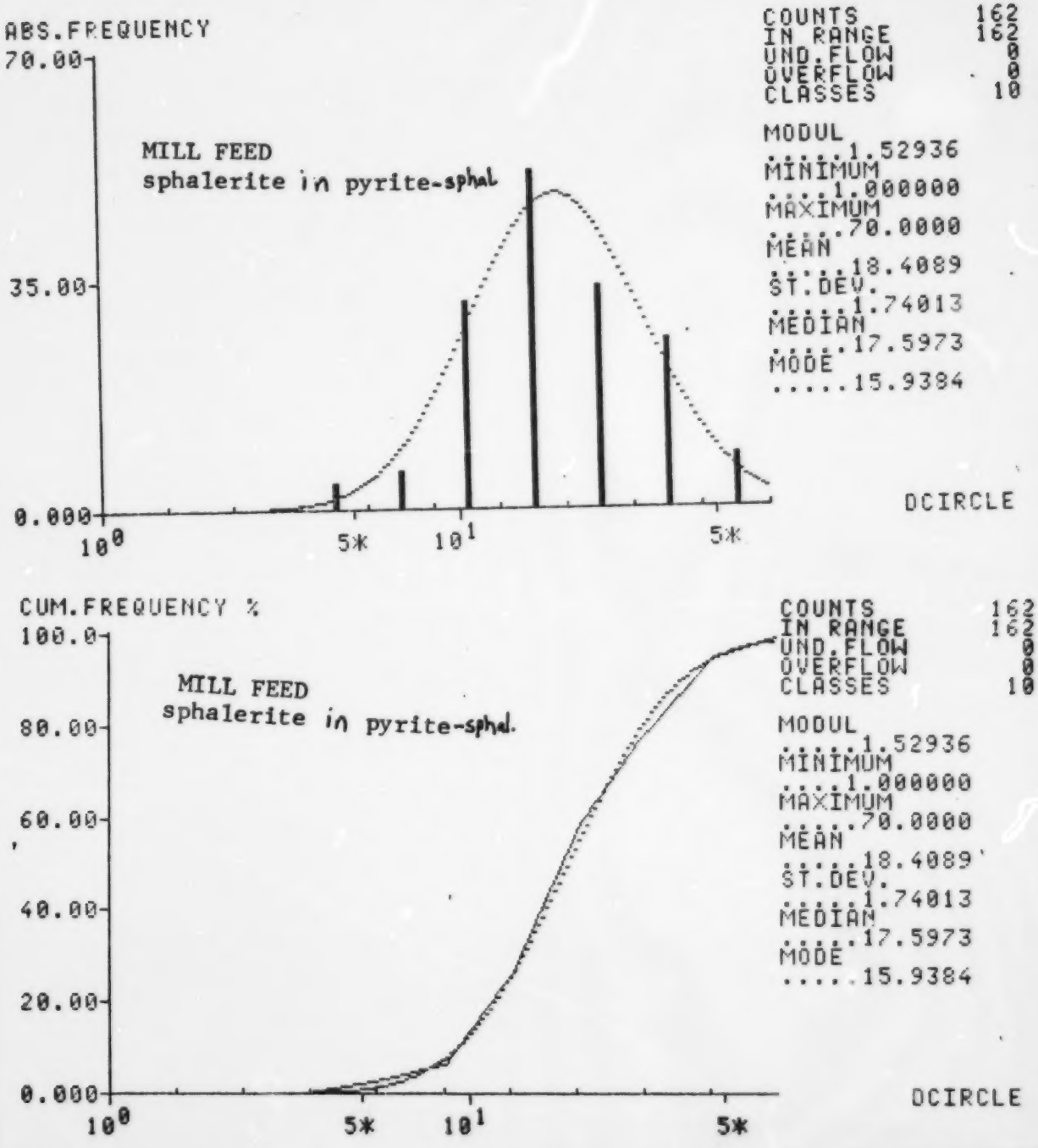

Fig. 12 - Size distribution of combined, sphalerite - pyrite grains, plotted as number of grains vs size in micrometers.

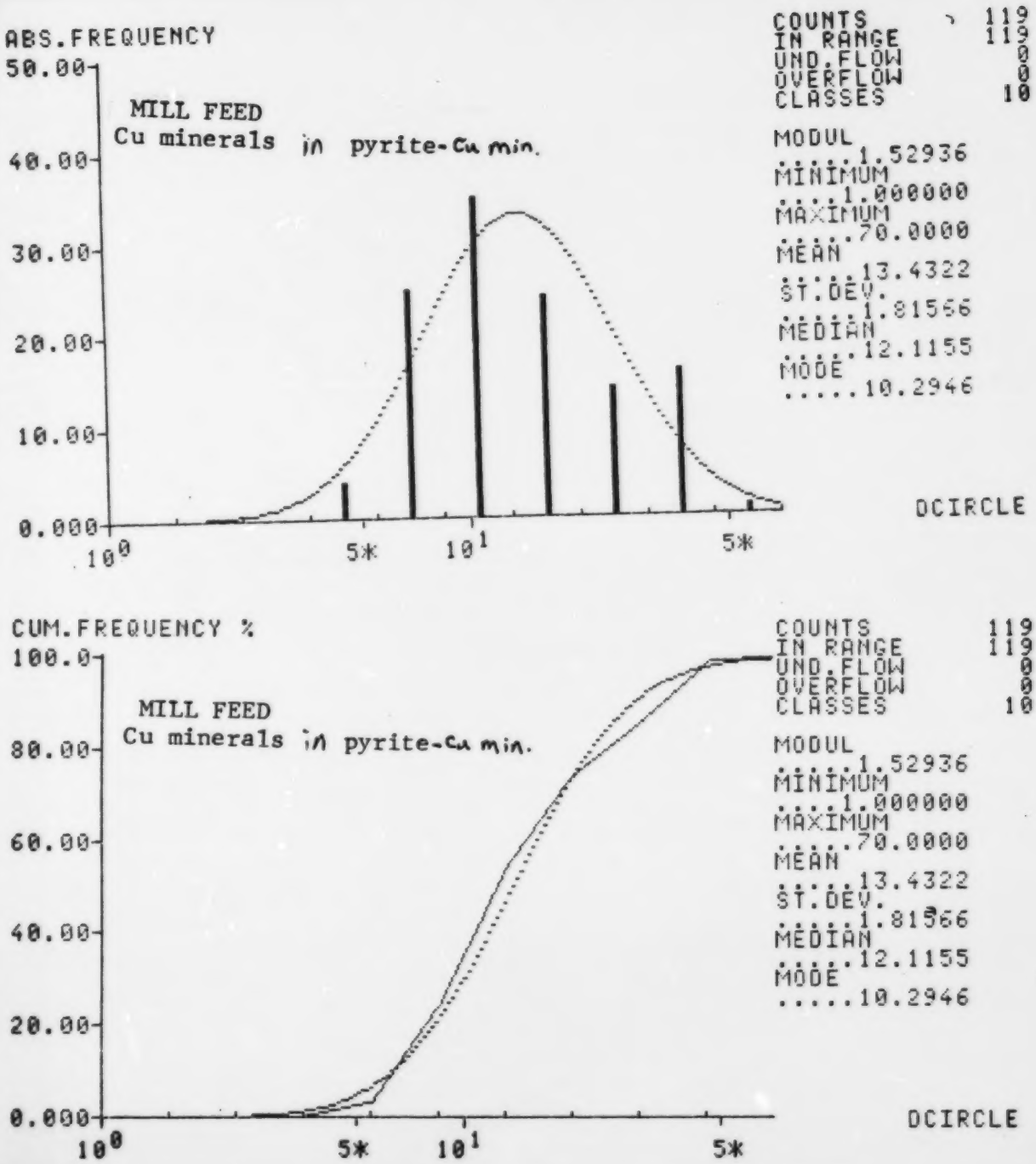

Fig. 13 - Size distributions of combined copper mineral - pyrite grains, plotted as number of grains vs size in micrometers.

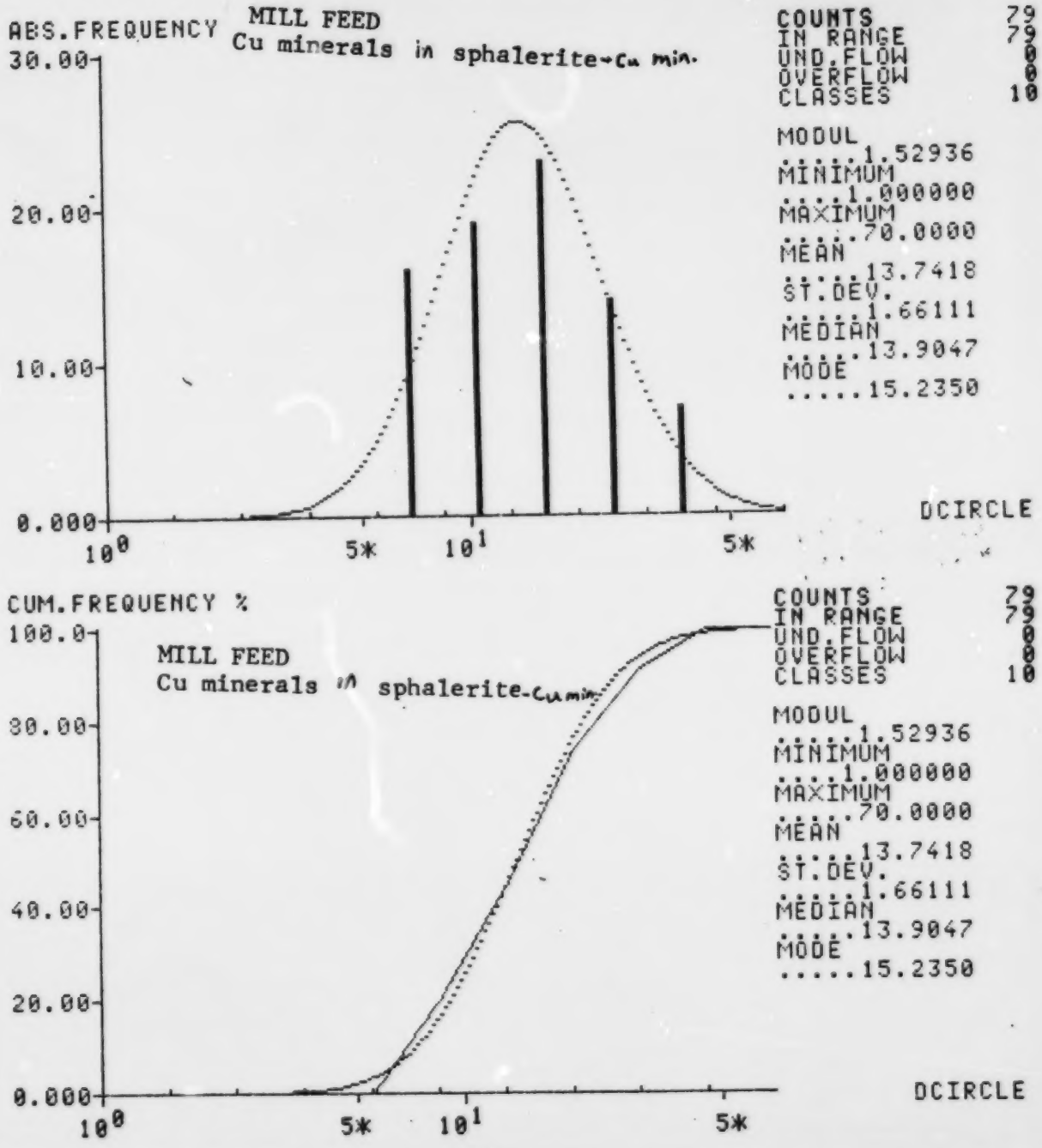

Fig. 14 - Size distribution of combined copper mineral - sphalerite grians, plotted as number of grains vs size in micrometers.

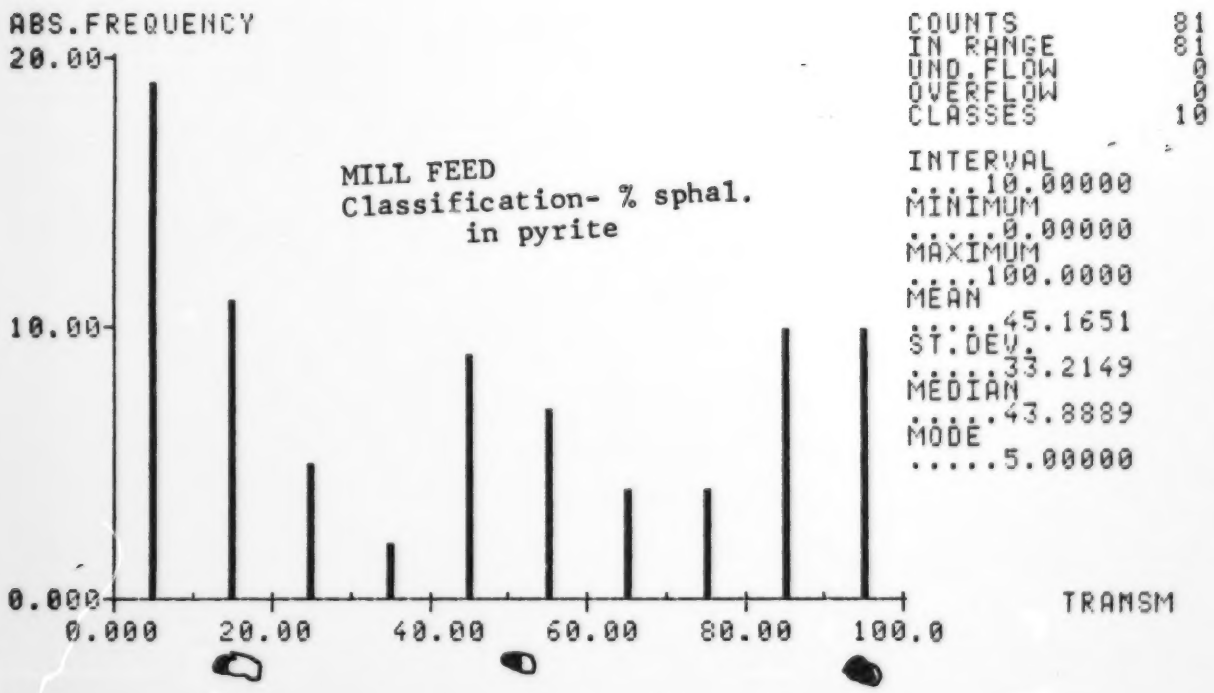

Fig. 15 - Classification diagram, plotted as number of grains vs % sphalerite in sphalerite pyrite particles.

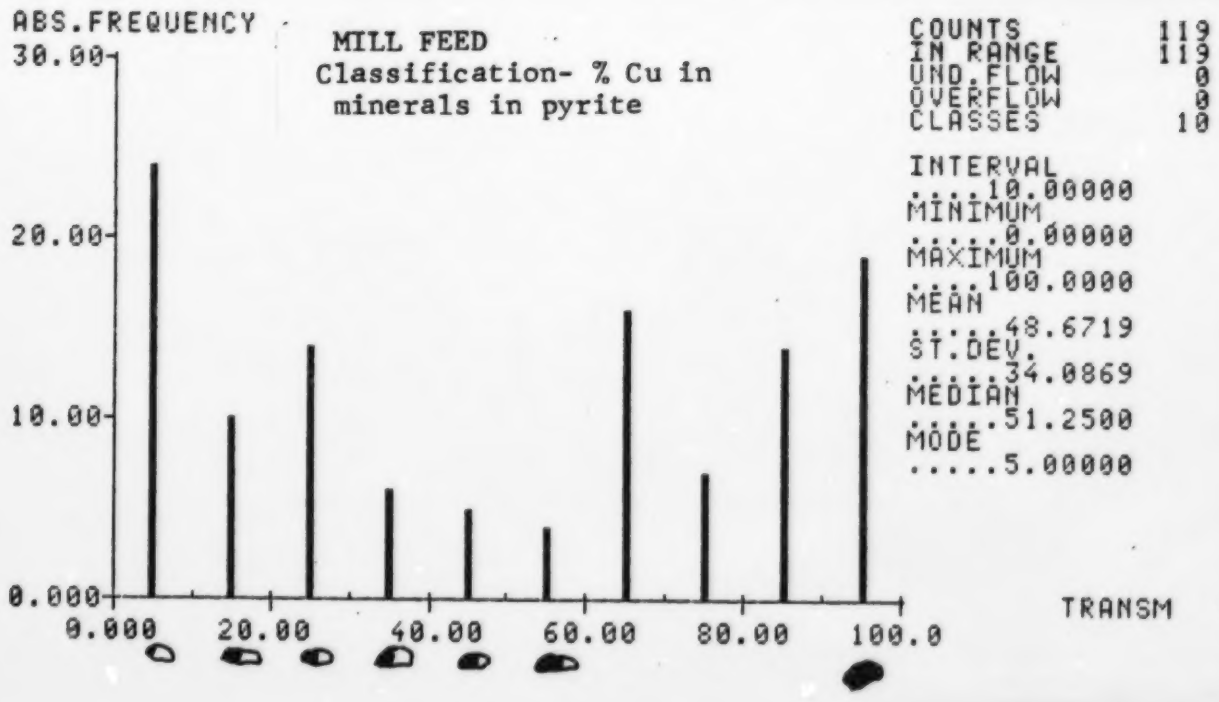

Fig. 16 - Classification diagram, plotted as number of grains vs % copper minerals in copper minerals - pyrite particles.

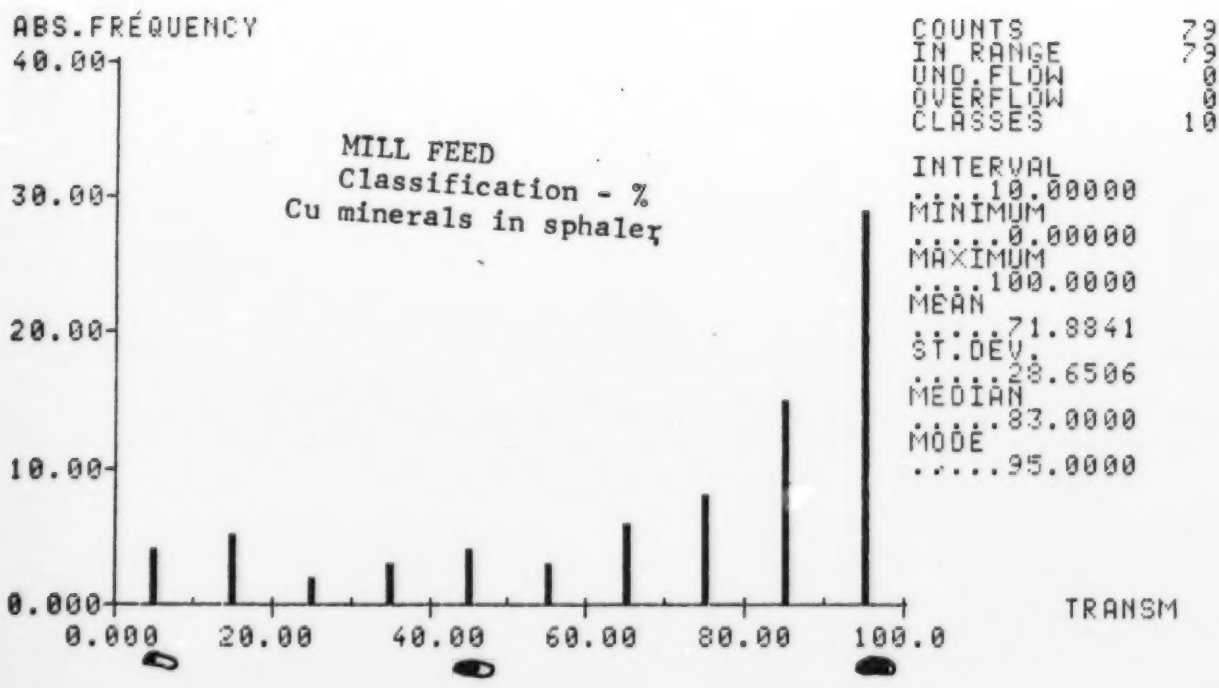

Fig. 17 - Classification diagram plotted as number of grains vs % copper minerals in copper minerals - sphalerite particles.